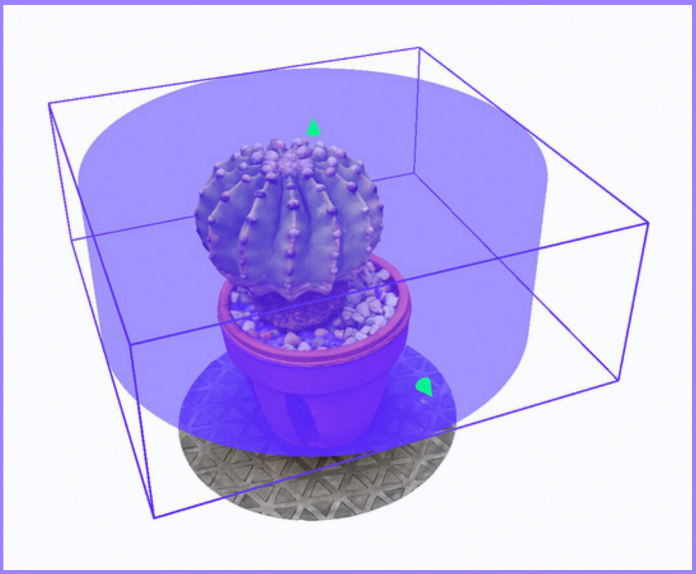
Biomimicry Design



In this collaboration between the **Design Center** and **The Arthur Ross Greenhouse**, we introduce concepts and examples of **biomimicry design**.

Nick Gershberg of Barnard's Greenhouse talks through identifying plant properties to inspire biomimicry design ideation.

We then learn how to apply these biomimetic design principles to our own projects with tools and prototyping processes at the Design Center with Coordinator **Rebecca Naegele**.

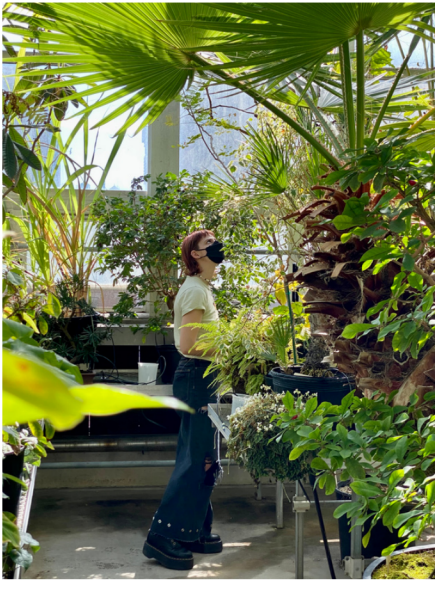
What is Biomimicry Design?

Biomimicry Design is an approach to innovation that looks to nature for inspiration in solving human problems and challenges.

It involves **observing and studying** how plants, animals, and other organisms have evolved to survive and thrive in their natural environments, and then using those insights to **inform the design** of human technologies, systems, and processes.

The goal of biomimicry design is to **create sustainable and efficient solutions** in harmony with nature, rather than working against it.

Biomimicry derives from ***bios***,
meaning life, and ***mimesis***, to imitate



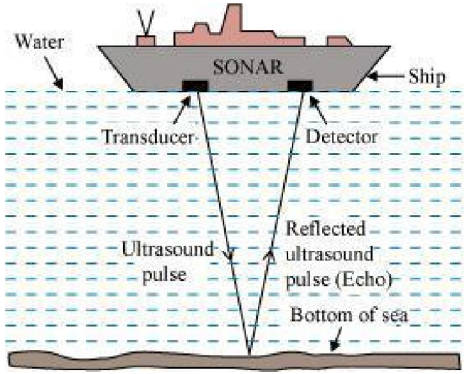
By **emulating the patterns and strategies found in nature**, biomimicry designers aim to create products and systems that are not only more effective and efficient, but also more **resilient and adaptable** to changing conditions.

Biomimicry Examples

Watch: Biomimicry 0:45 - 2:28 min
video.alexanderstreet.com/watch/bio-mimicry
in Columbia University Library

Velcro was developed when De Mestral recognized burred seed pods stuck to his clothing and dog's fur by a hooked burr design. This function was leveraged and applied for its temporary adhesion properties.

Sonar (short for **so**und **na**vigation and **r**anging) technology was inspired by the communication of bats and dolphins, who use sounds waves and echoes to communicate in and out of water.



More Biomimicry Examples

Nature's Spiral

By examining how fluids move in the natural world, PAX Water Tech Founder **Jay Harman developed a small yet powerful impeller** that mimics the spiral flow patterns found in whirlpools and tornados to improve water quality in storage tanks.

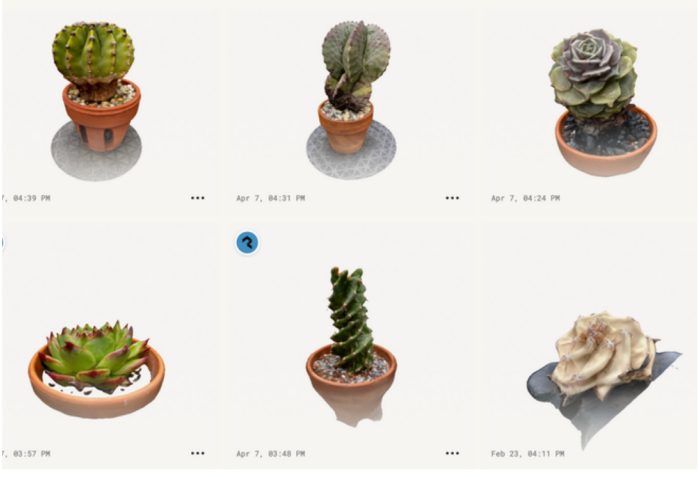
The 6 inch **"Lily" impeller resembles a calla lily** and can mix a 10 million gallon water storage tank using the same energy footprint as three 100-watt light bulbs - more efficient than any other existing methods for water storage mixing.

Observation & Analysis

We have loofahs, sweet gum seed pods, and coral to observe. What **forms, textures, and structures** make up these once-living objects?

Examine these objects with the help of touch, close observation, magnification, illumination, and sketching what you see. Note textures, repetition of form, and growth pattern to understand the functions of these natural forms.

3D Scanning with Polycam



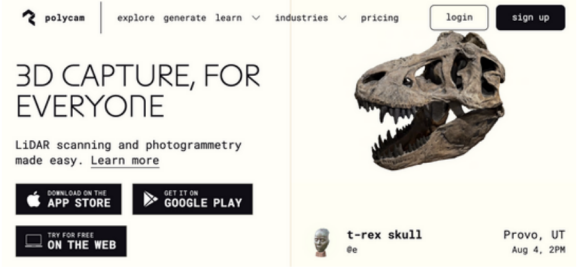
We have a well-lit setup at the greenhouse conducive to 3D scanning. Stark shadows will confuse the scanning app - diffuse light is best. Avoid complicated backgrounds.

We'll also have turntables to help with scanning plants to reference and model from later. It may take a few tries to make a sufficient 3D scan.

Polycam uses Photogrammetry

Photogrammetry is the science of obtaining measurements and 3D data from photographs. It involves taking multiple photographs of an object or scene from different angles and then using software to create a 3D model of the object.

Download (free version) of Polycam App!



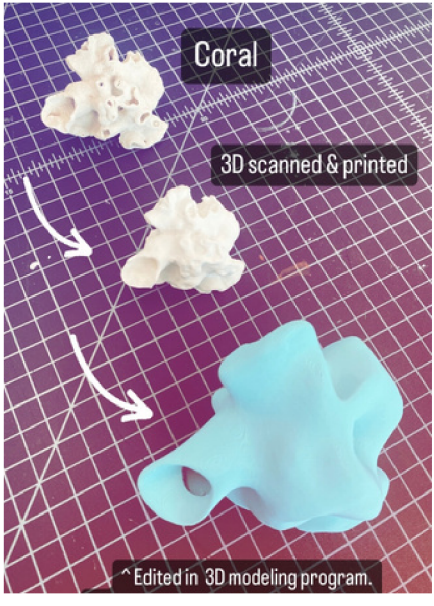
The Problem is the Solution

One of permaculture's important concepts, ***the problem is the solution*** means that any perceived problem is an opportunity to generate a solution.

Ex: the problem of the burred seed pod sticking to De Mestral's clothing (actually an evolved seed dispersal method) produces the opportunity to **see this function as a solution**: creating a temporary attachment system (velcro) inspired by the hook design of these biological forms.

Prototyping Process

Identify a natural form you'd like to work with and 3D scan it to begin. Here, a coral specimen is inspiration for human housing based on this marine life housing structure. Staff member Aishah Bostani created this biomimicry-influenced architectural prototype.



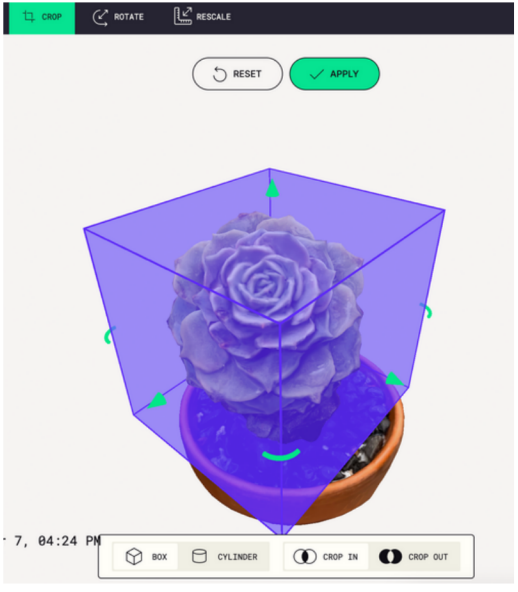
The 3D scan file is imported into a modeling program (Fusion360 or Rhino) to modify and edit.

The form is simplified into a smooth and hollowed architectural model prototype.

Spiral shaped cactus inspires water collection structure prototype

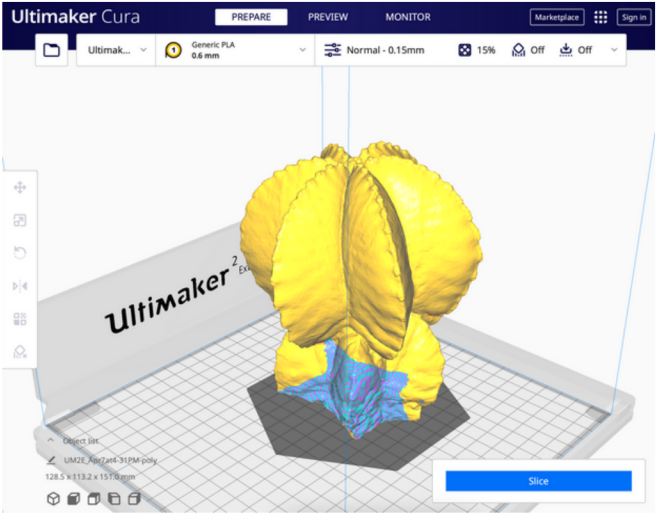
This spiral shaped cactus from Barnard Greenhouse is 3D scanned using Polycam app. The spiral form is simplified in a 3D modeling program, edited and 3D printed to create a water collection prototype. This prototype was made by Design Center Graduate Assistant Aishah Bostani.

Editing your 3D scan in Polycam



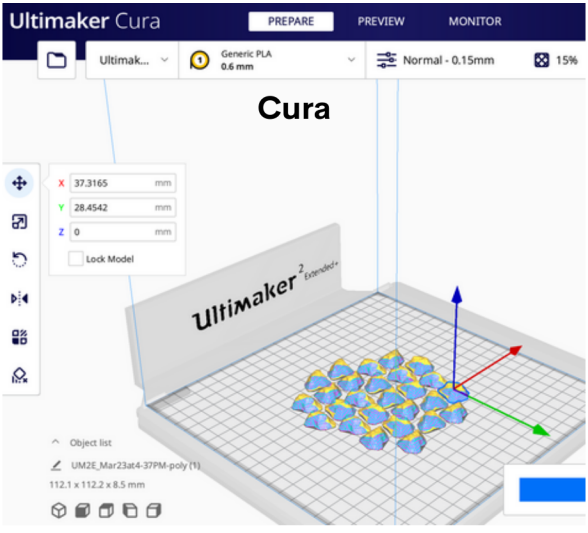
Cropping is fairly intuitive - you'll see rectangular and cylindrical cropping tools to edit out any unwanted background information from the object you're trying to 3D scan. You can rotate your scanned object 360 degrees in the web platform or directly in the app.

Downloading your 3D scan/model file and uploading to Cura for 3D printing



Download the 3D scan from **Polycam** as a .GLTF or .STL file. Send the file to a nearby computer to open in Cura to 3D print this scan directly.

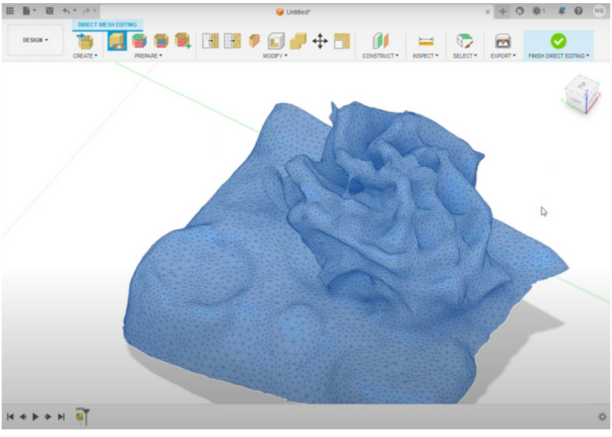
Cura is a free program to prepare files for 3D printing. Cura is available on all the Design Center's computers and laptops.



Cura can perform basic tasks to prepare your 3D model for printing including scaling, multiplying forms, rotating, and placement on the 3D print bed. Objects are printed by an additive process of subsequent layers of melted filament.

The program will “slice” your model into **additive layers** that our 3D printers can read, projecting print duration. We have 3D print filaments made of PLA, algae, flexible TPU, dissolvable PVA, etc.

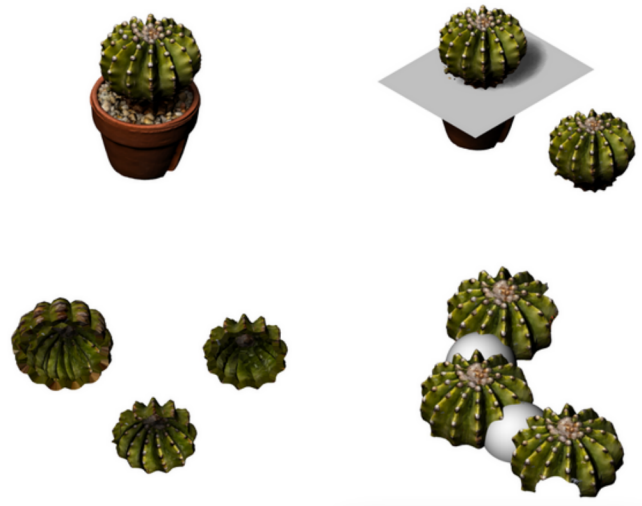
Converting your 3D scan to a 3D modeling format



Convert your .GLTF (3D Scan) file to a .STL file to edit it in another free 3D modeling program like Tinkercad or Fusion360. Rhino by Autodesk is another option.

Converter for GLTF to STL:
fabconvert.com/convert/gltf/to/stl

3D Modeling with Rhino



This 3D scanned cactus form from Barnard's Greenhouse inspired Aishah's **domicile model to leverage rainwater catch and harvesting in dry environments**. 3D modeling can facilitate translating and transforming biological forms to a legible architectural model or prototype with a form and function drawn from nature.

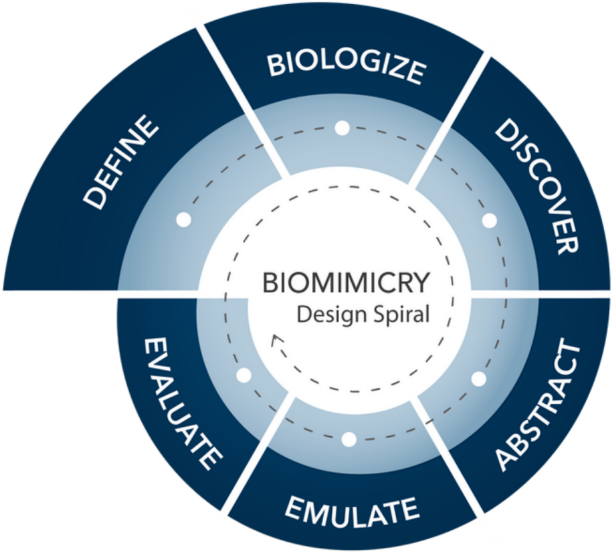
3D Modeling with Rhino
Step by step

1. **Import** the 3D scan as an .OBJ file into Rhino
2. **Split** model into desired components
    a. Draw plane
    b. Use **Split** command or **MeshBooleanSplit**
3. **Reduce Mesh** using ReduceMesh command
4. Smooth edges using **Smooth** command
5. Offset to create thickness using **OffsetMesh** command
6. **Play with orientation** and inclusion of other shapes by using commands like:
    a. MeshBooleanUnion to **combine objects**
    b. MeshBooleanIntersection to take the **intersection** of two objects
    c. MeshBooleanDifference to take the difference of one object from the other
    d. MeshBooleanSplit to **separate** two objects

Grounding the process in observation

Images from the workshop in Arthur Ross Greenhouse (Milbank rooftop) and Design Center, (Milstein Center ground floor), Barnard College

Further Resources



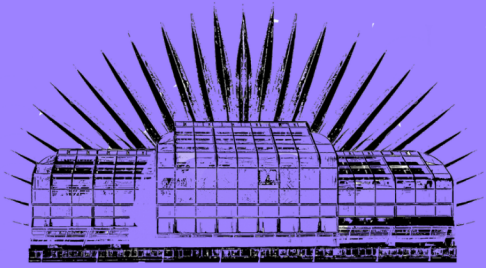
The Biomimicry Toolbox toolbox.biomimicry.org

The Biomimicry Institute biomimicry.org

Biomimicry 3.8 biomimicry.net

Learn Biomimicry learnbiomimicry.com

This zine was created by Rebecca Naegele,
Design Center Coordinator, Spring 2023



THE ARTHUR ROSS GREENHOUSE
AT BARNARD COLLEGE

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